

A technological look at the Torion T-9 detector for portable GC-MS

KVCV, GC studiedag: "smart solutions" voor het labo

Timon Huybrighs

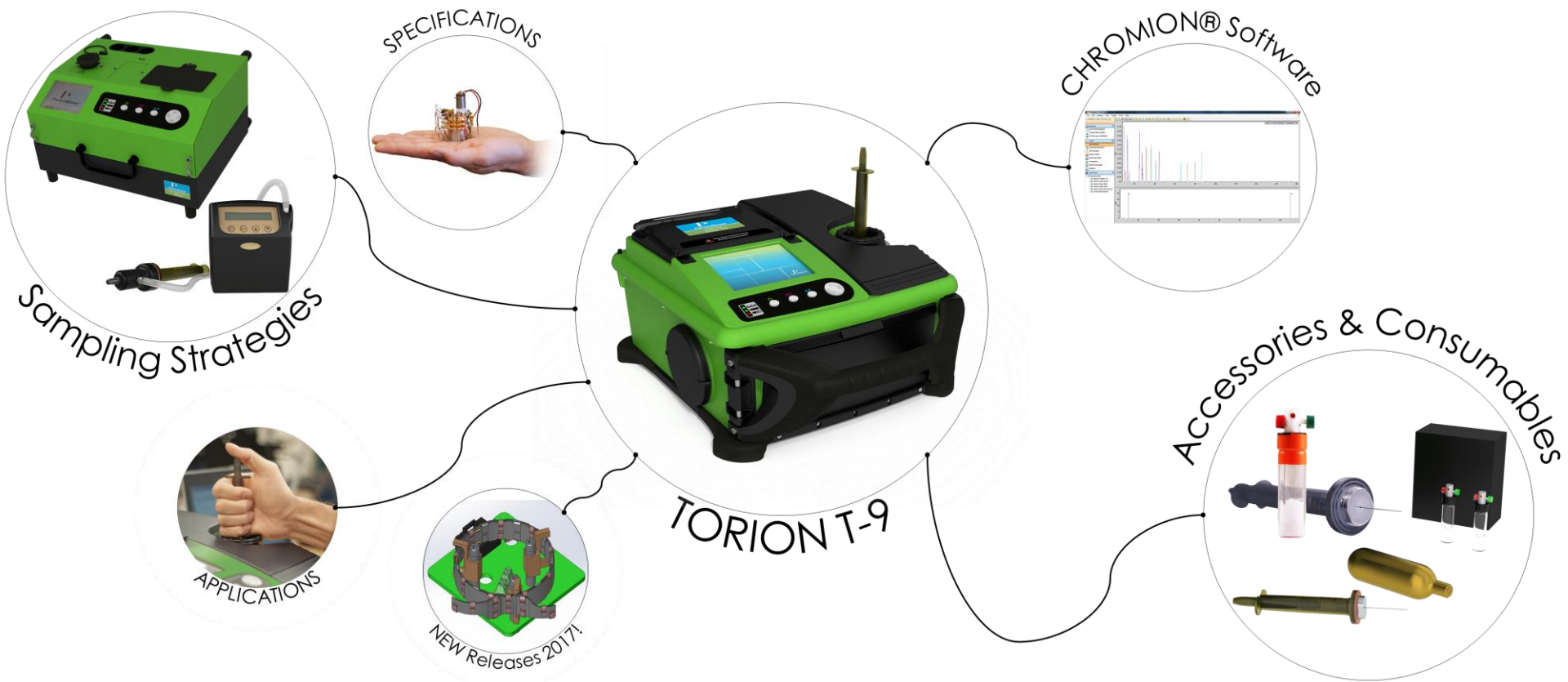
Grobbendonk, 12 oktober 2017



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INTOURS 2017

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IN?

TORION Presentation Overview



Torion® T-9: Person Portable GC/MS



World's
lightest,
fastest
most
portable
GC/MS

Key Features

- Portable, lightweight GC/MS
- Operates under harsh conditions
- Routine calibration
- Automated performance validation
- 5 min startup and cycle times
- 12 samples per hour
- Battery power for 2.5 hours
- On-board helium cartridge



PORTABLE

Only 32 lbs. (14.5 kg)



FAST

5 min/sample



EASY

Intuitive GUI



RELIABLE

Rugged design

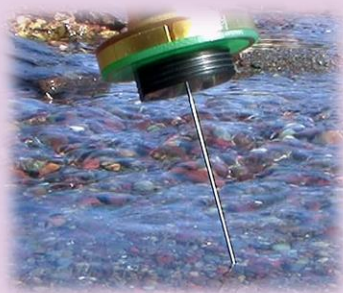
Custodion™ Sampling Devices: SPME & Needle Trap



Quick and Easy Sampling
Single-handed collection
Automatically triggers the
system to start upon injection

Key Features

- Collects Samples quickly
- Direct interface to T-9
- All sample types
 - Liquids
 - Gasses and Vapors
 - Dissolved Solids



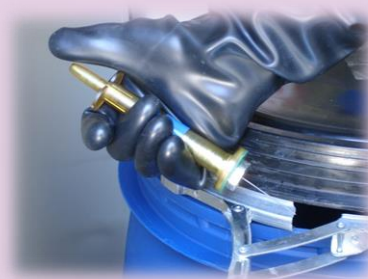
SPME

Liquids



SPME

Dissolved Solids



SPME

Vapors



NT AIR SAMPLING

Collect Anywhere

Comprehensive and easy Field Sampling

Clairion™: Portable Air Sampler



Flexible Field Sampling
Collect anywhere
High & low volumes
Dilute Samples

Key Features

- Hand held
- Rechargeable battery
- Interface to Needle Trap
- Interface to conventional traps
- Compatible with SPS-3 and T-9
- 27 Hr operation on a single charge at 1 L/min flows
- Battery power for 2.5 hours



PORTABLE

Hand-Held



NT INTERFACE

Abundant Samples



CT INTERFACE

Dilute Samples



EASY SAMPLING

Collect Anywhere

SPS™-3: Sample Prep Station

Key Features

- 2 Sample desorption modules
- Internal standard Module
- Solvent-less internal standards
- 20 installed methods
- Fast startup and cycle times
- Battery power for 2.5 hours
- 15–20 desorptions per battery charge
- On-board helium cartridge

Rapid Field Sampling
Concentrate Samples
Increase sensitivity
Add IS
In-field Quantitation



PORTABLE

Only 10 lbs. (4.5 kg)



FLEXIBLE

Configurable



SD MODULE

Concentrate Sample



IS MODULE

Quantitation

Rapid Field Sampling and Quantitation

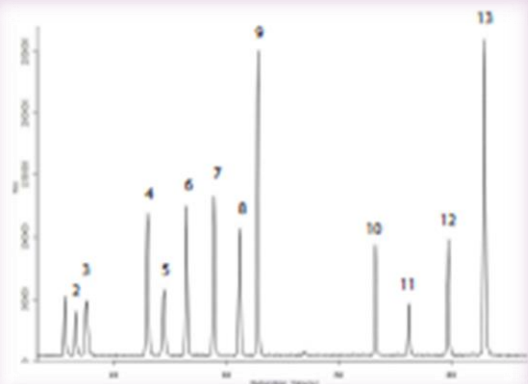
Calion Standards: Validation and Internal Standards



Peace of mind
In-Field System Validation
Reliable performance
Quantitative results
Confidence in the results

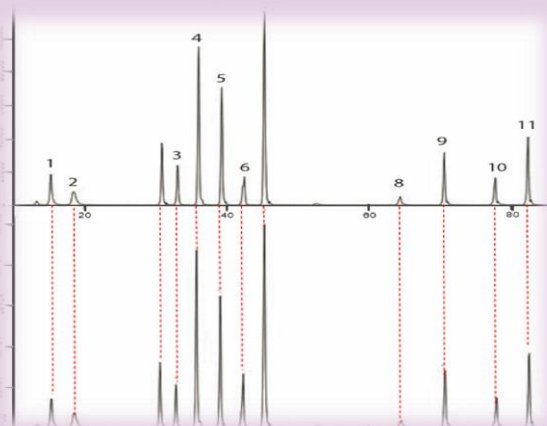
Key Features

- Calion PV Mix: 13 standards
- Calion IS: 2 Quantitation Standards
- Solvent-less and stable
- Mass calibration
- Retention time calibration
- Performance verification
- Confident Quantitation



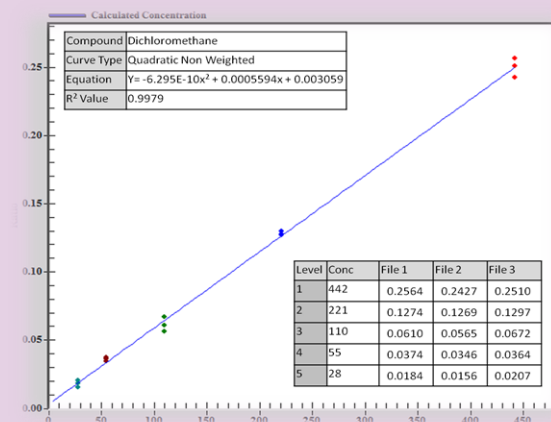
Validation

Ensure System Performance



Calibration

Reproducible Results

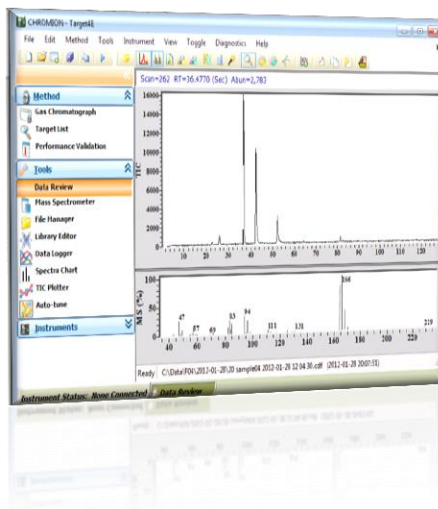


Quantitation

Reliable Results

On the spot reliable and traceable results

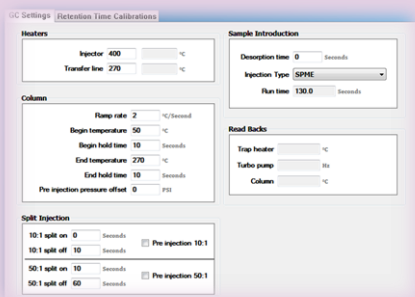
Chromion™: Intuitive Software



Easy to Use & Powerful
Intuitive GUI
Wizards
In-field data analysis

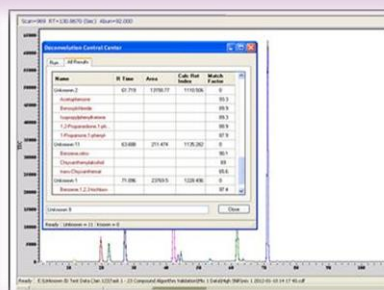
Key Features

- Simple Easy to use GUI
- Full instrument control
- Full data review
- Proprietary deconvolution algorithm
- Customized peak detection
- Quantitation
- NIST and Custom libraries



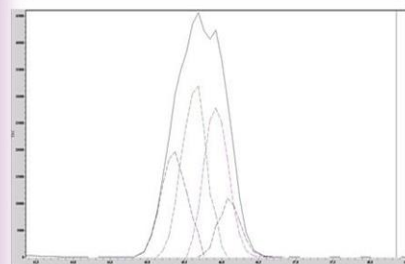
CONTROL

Full data review



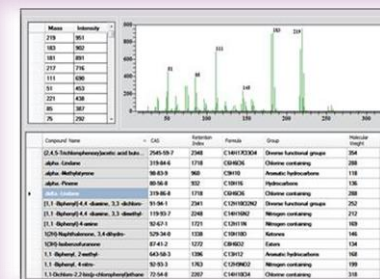
MEASURE

Full analytical capabilities



ANALYZE

Deconvolution



IDENTIFY

NIST & Custom Libraries

Consumables & Accessories



Key Features

- Consumables
- Replacement seals
- Available in kits
- No service parts
- Service not done in the field

EXTENDED OPERATION

Extra Batteries and He Gas

HIGHER THROUGHPUT

Additional SPME, NT, CT

SMOOTH OPERATION

Seals, interfaces

The difference between...

Presumably portable



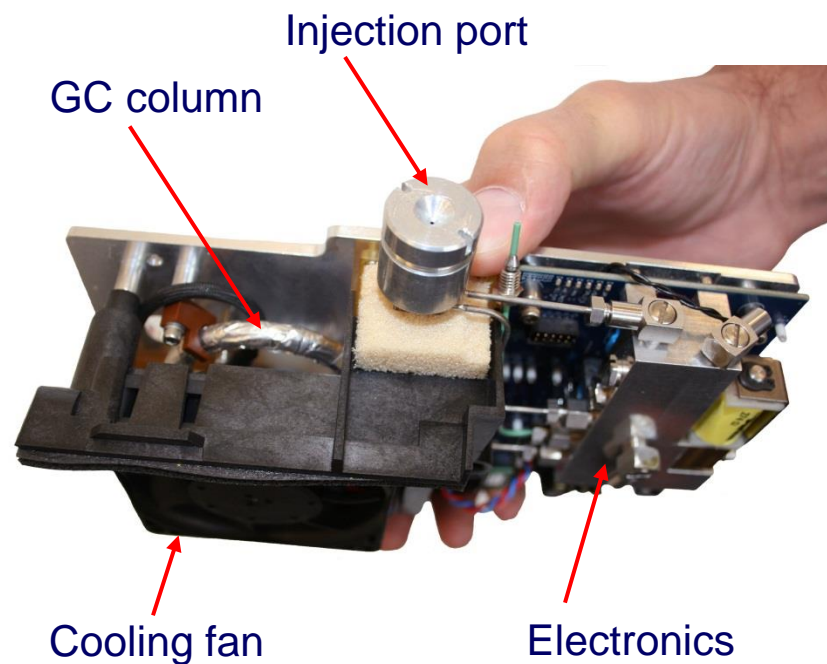
Truely portable



Miniaturization of the GC

Low Thermal Mass (LTM) GC:

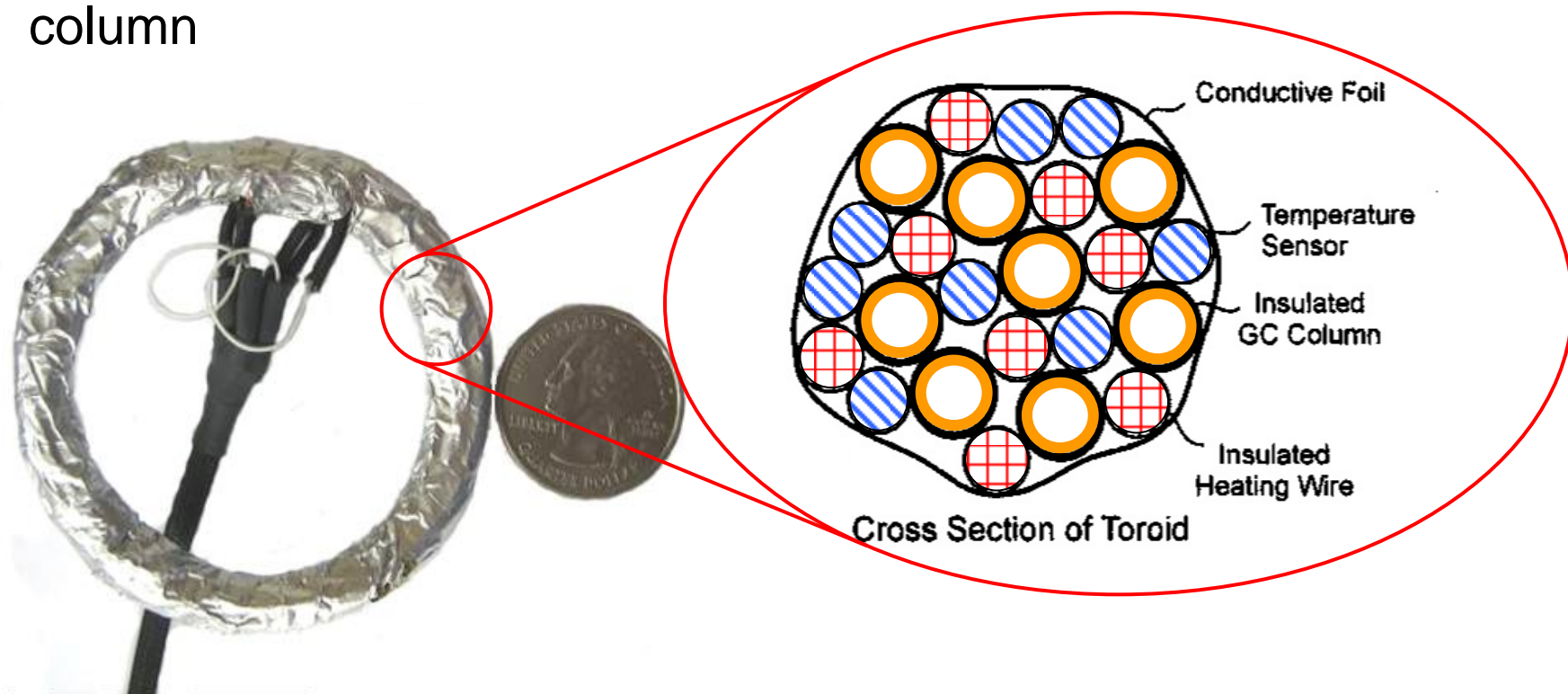
- Smaller instrumentation
- Lower operating power
- Faster heating
- Faster cooling



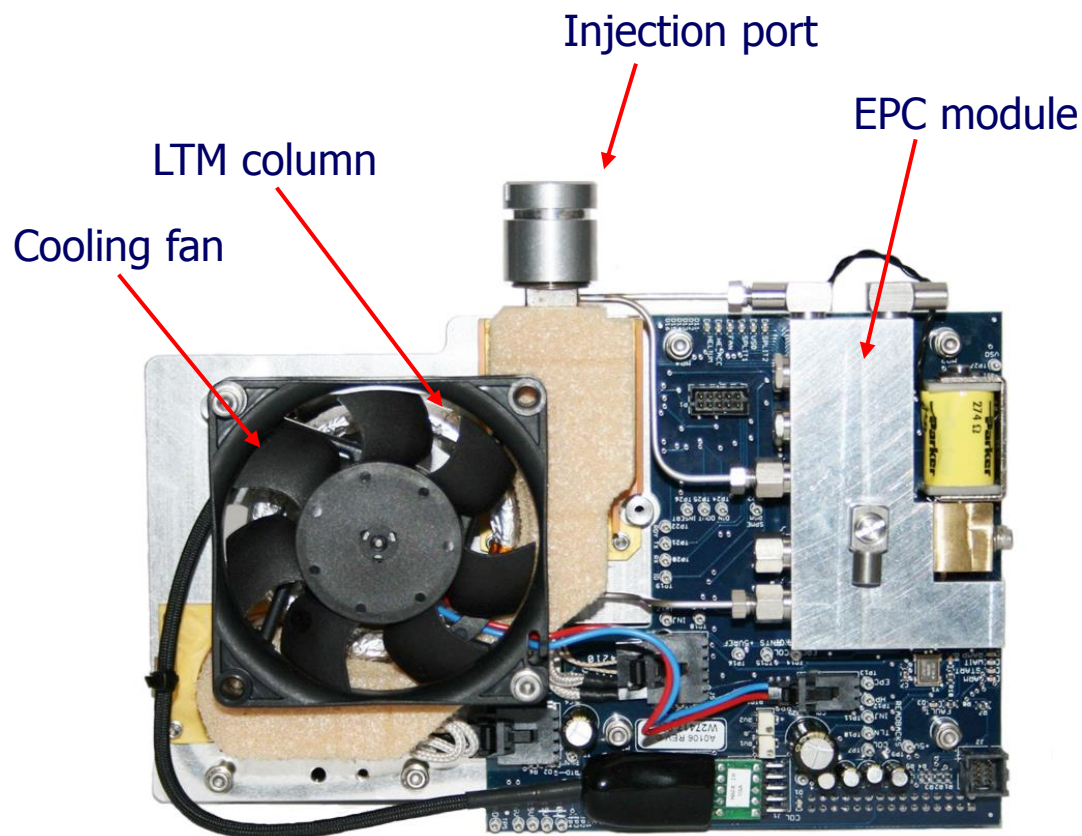
TORION™ T-9 LTM GC

Resistively Heated Column Technology

- LTM GC uses direct electrical resistive heating of the capillary column



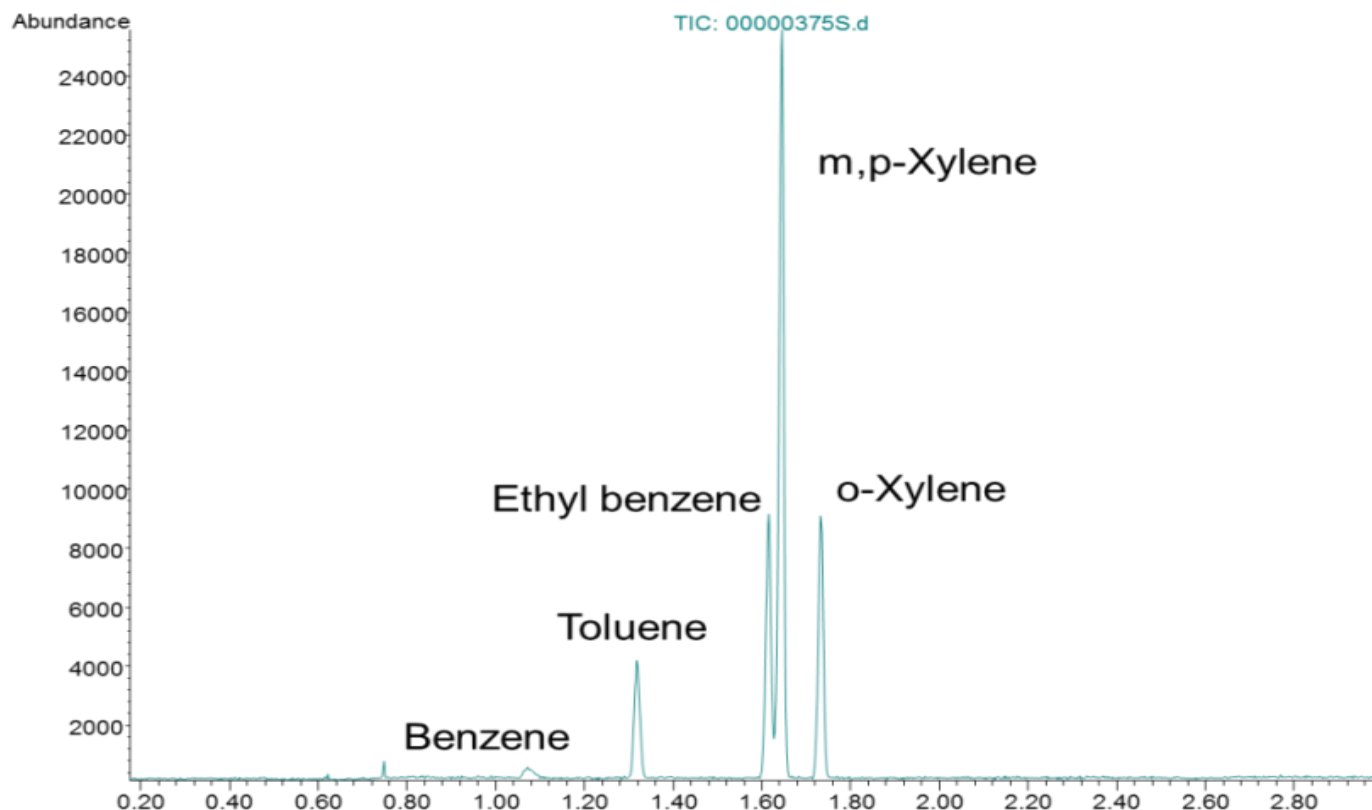
Low Thermal Mass Capillary GC



Typical GC Conditions:

- Column: MXT-5 (5 m x 0.1 mmID x 0.4 μ m df)
- Mobile Phase: Helium
- Head Pressure: 25 psig
- Column Max Flow: ~0.4 mL/min @ 20°C
- Split-splitless Injection: Selectable split ratios: 0, 10, 50, and 60 to 1
- Program: 50°C (hold 10 s) to 300°C (hold 10 s) @ 120°C/min
- GC-TMS run time: <5 min (including GC cooling cycle and data processing)

Example chromatogram: BTEX in water

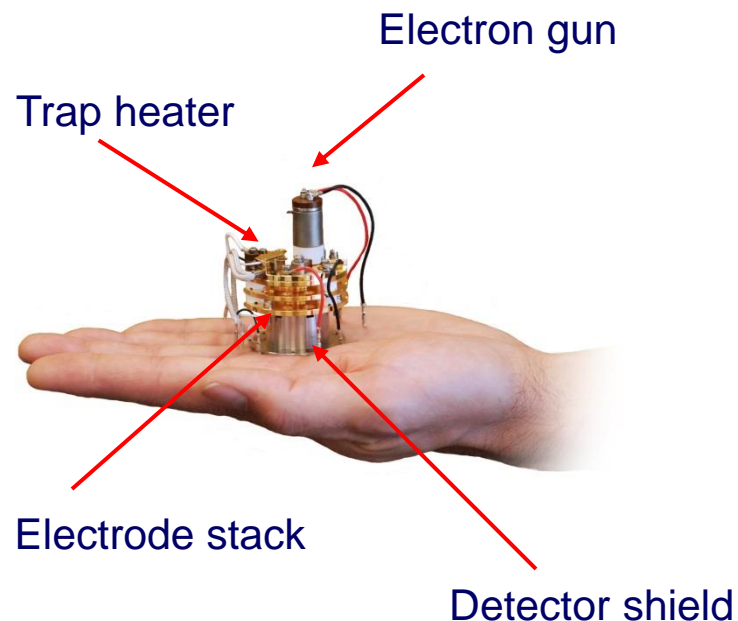


TIC chromatogram of 5 ppb BTEX in H₂O. PDMS needle trap extraction of 5 mL sample, 1 mL/min flow rate (using a syringe pump). Split 10:1 mode; 20 s, 270°C injection; 40°C hold 20 s initial, 0.6°C/s rate, 230°C hold 10 s final; 16 psi injector and 18 psi purging pressure.

Miniaturization of the MS

Toroidal Ion Trap MS (TMS):

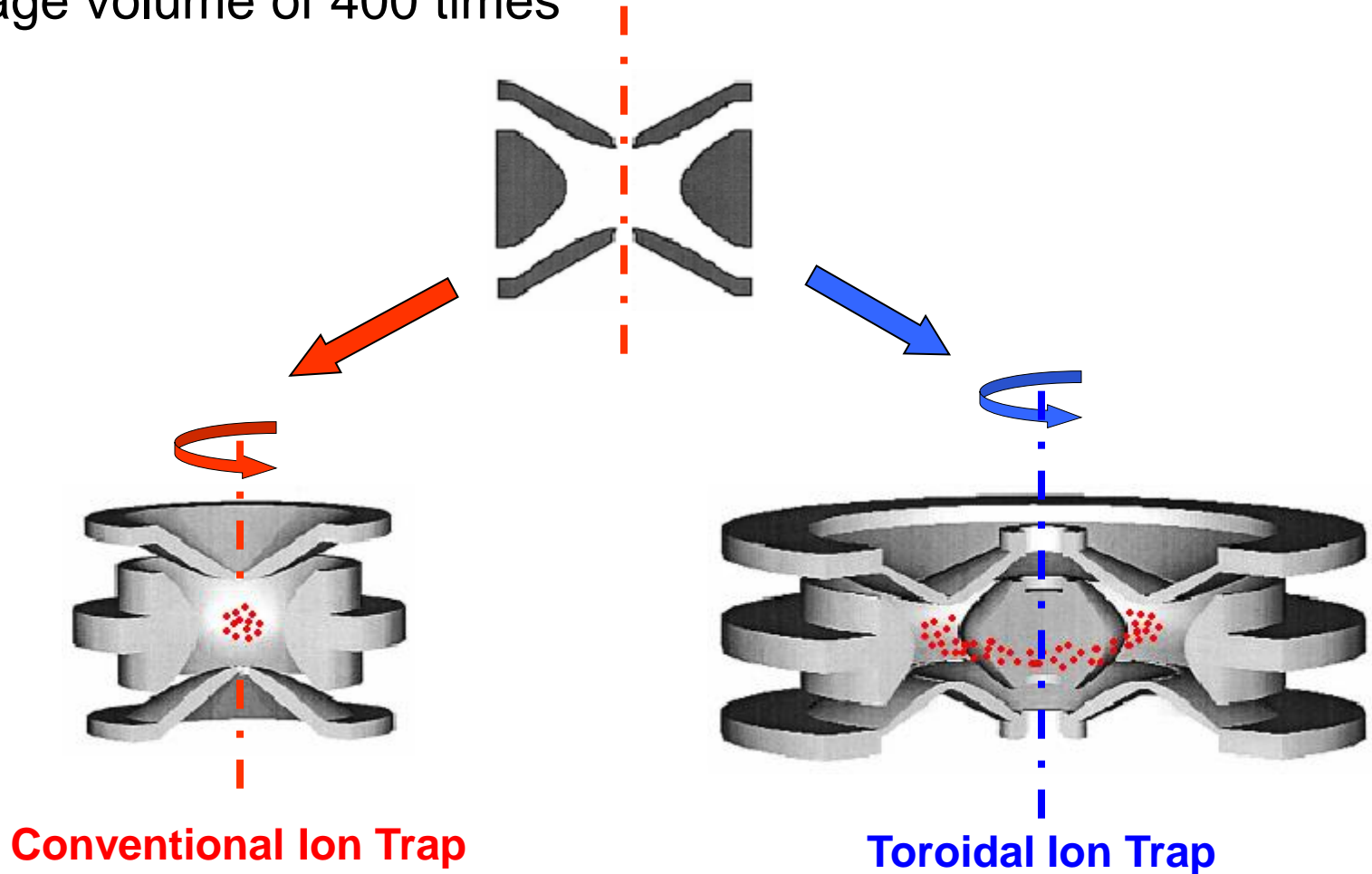
- Simple, rugged design (no critical alignment of ion optics)
- Less stringent vacuum requirements
- High duty cycle → high sensitivity
- Low power (especially with small ion trap mass analyzers)



TORION™ T-9 TMS

Toroidal Ion Trap... What does that mean?

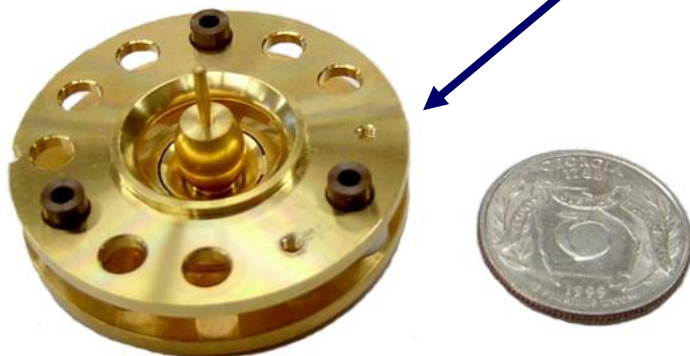
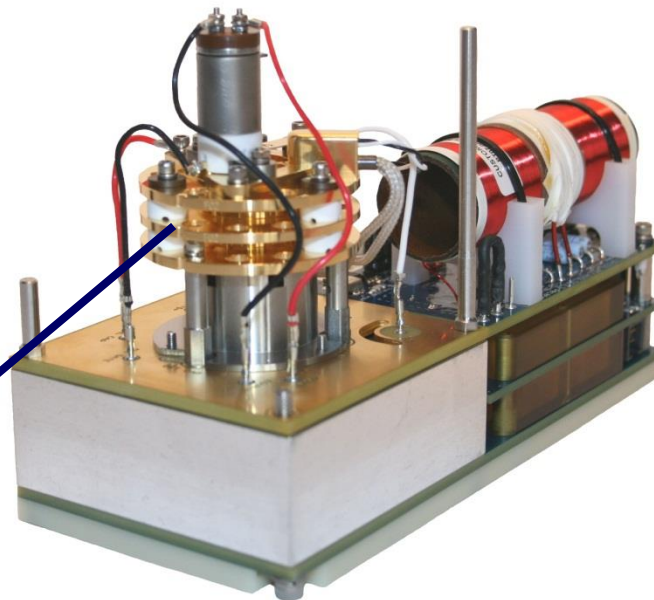
- The toroidal design of the ion trap offers an increase in the ion storage volume of 400 times



The Torion™ T-9 Ion Trap Module

Removable TMS ion trap:

- easy to remove (2 screws)
- alignment guide pins
- front panel access door
- wire connection coding



**When sample preparation
is not an option**



Sampling made easy with Torion's Portable Sampling Accessories

Solid Phase Microextraction (SPME)



CUSTODION® SPME Syringes



Field Sampling Must Be:

- ✓ **Quick**: single step sample extraction and concentration
- ✓ **Easy** single-handed operation in protective glove
- ✓ **Reliable** sampling of gases, liquids and solids

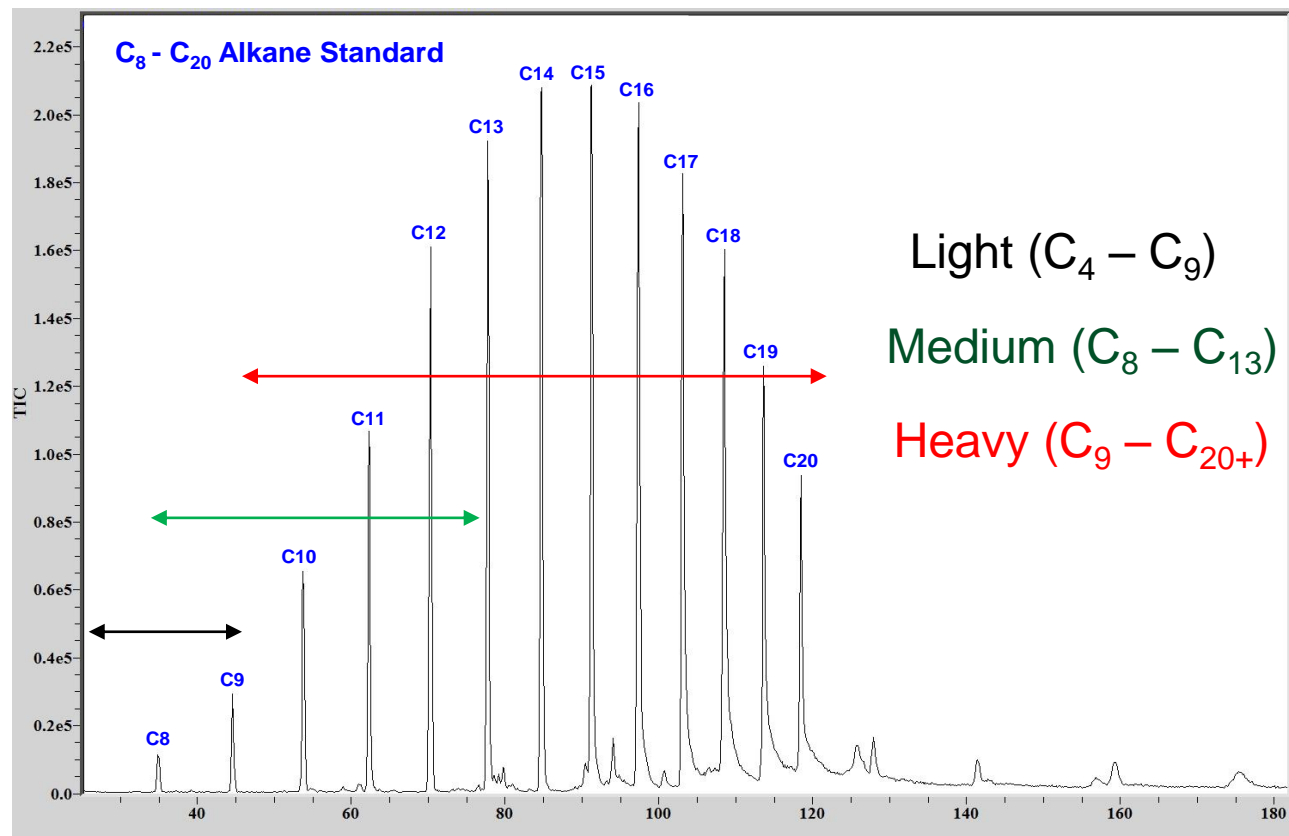
CUSTODION® SPME Syringes



- Reliable sampling of air, liquid and solid samples
 - 19 gauge blunt needle
 - DVB/PDMS fiber
- One-handed push button operation extends and retracts sampling fiber
 - Easy like a ball-point pen
- Rapid, single step sample extraction and concentration
 - Directly interfaces with GC

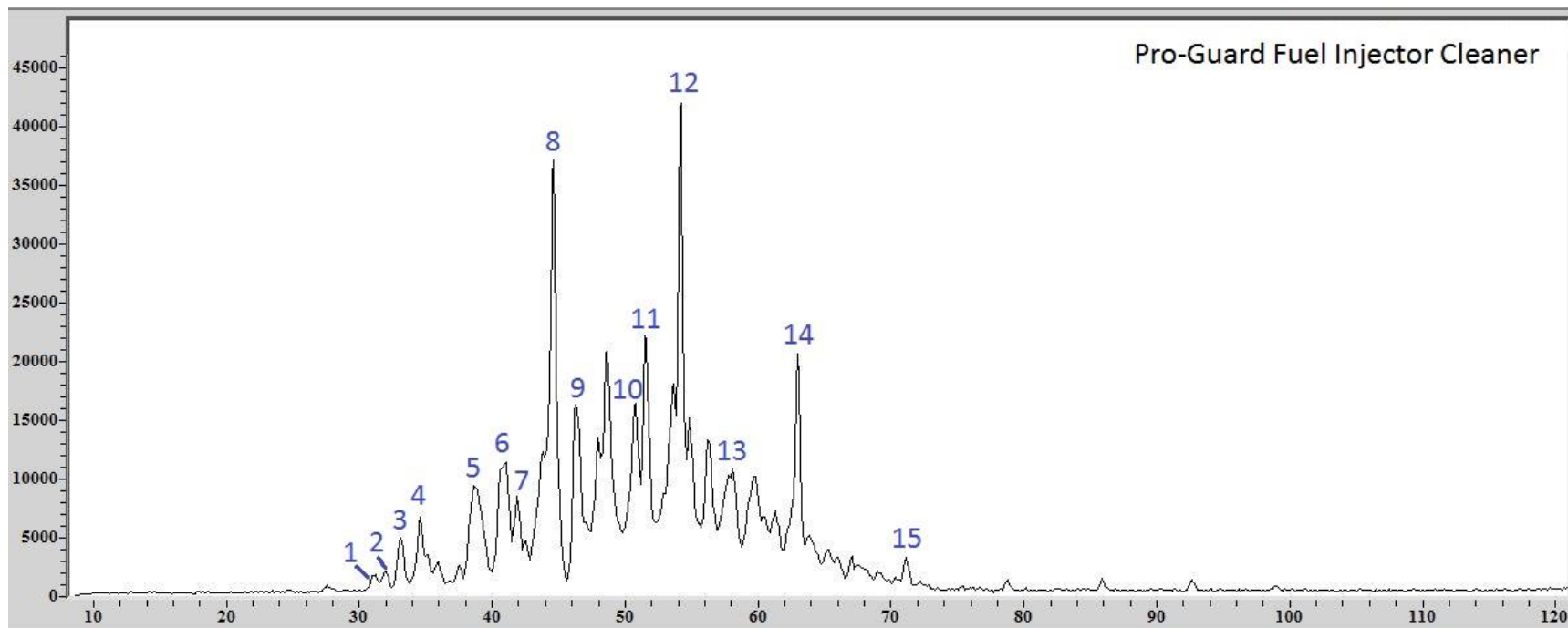
Quickly determine the profiles of ignitable residues

- Identify ignitable liquid residues of all ASTM E1618 Classifications
- Less than 4 minutes per analysis



Pro-Guard Fuel Injector Cleaner

– GC/MS via SPME



1. Hexane, 2,5-dimethyl-

2. Toluene

3. Cyclohexane, 1,3-dimethyl-,cis-

4. Octane

5. Cyclohexane, ethyl-

6. Cyclohexane, 1,3,5-trimethyl-

7. p-Xylene

8. o-Xylene

9. Cyclohexane, 1-ethyl-4-methyl-,cis-

10. Benzene, propyl-

11. Benzene, 1-ethyl-2-methyl-

12. Decane, 2,2,8-trimethyl-

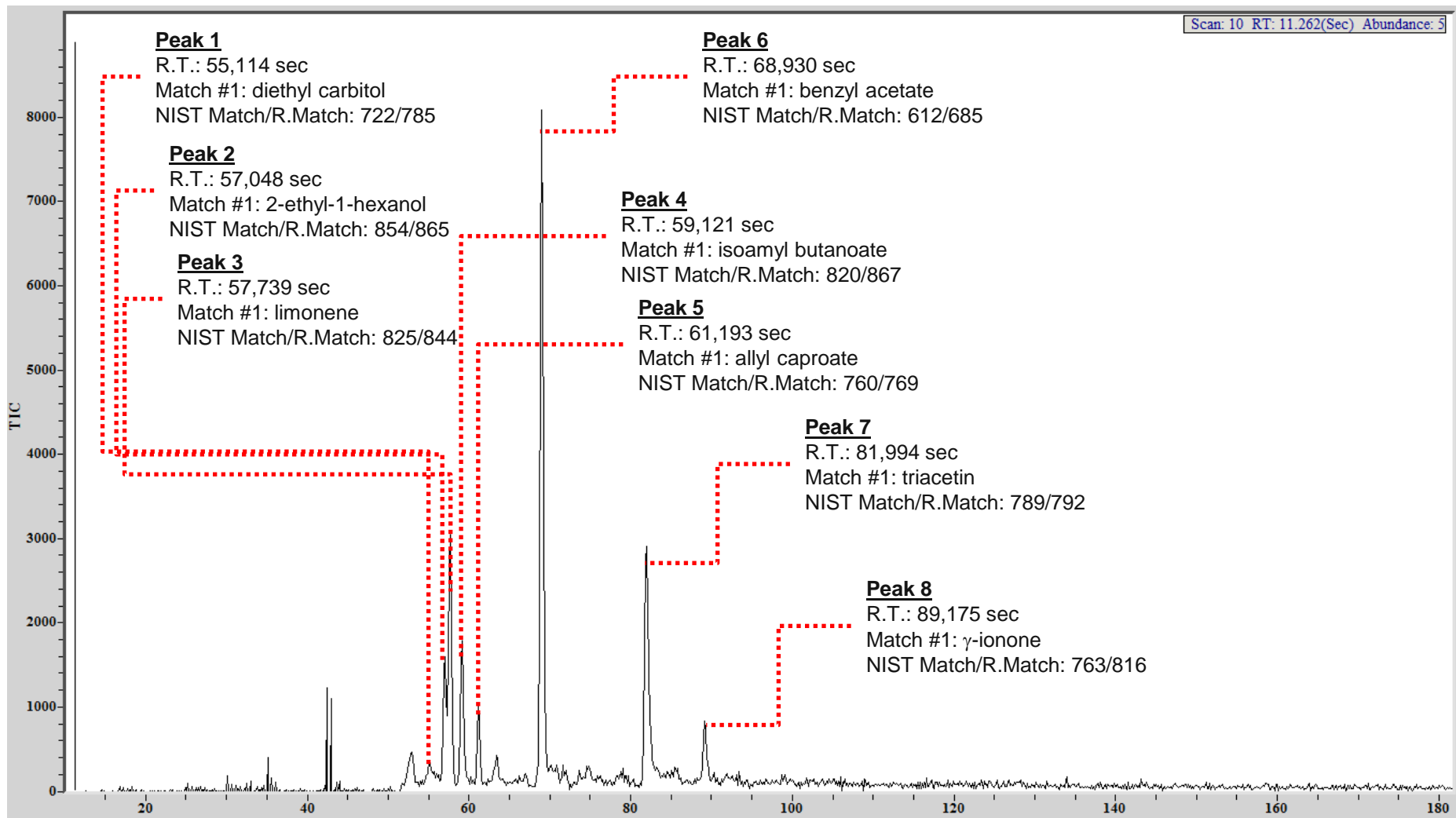
13. Benzene, 4-ethyl-1,2-dimethyl-

14. Benzene, 1,2,4,5-tetramethyl-

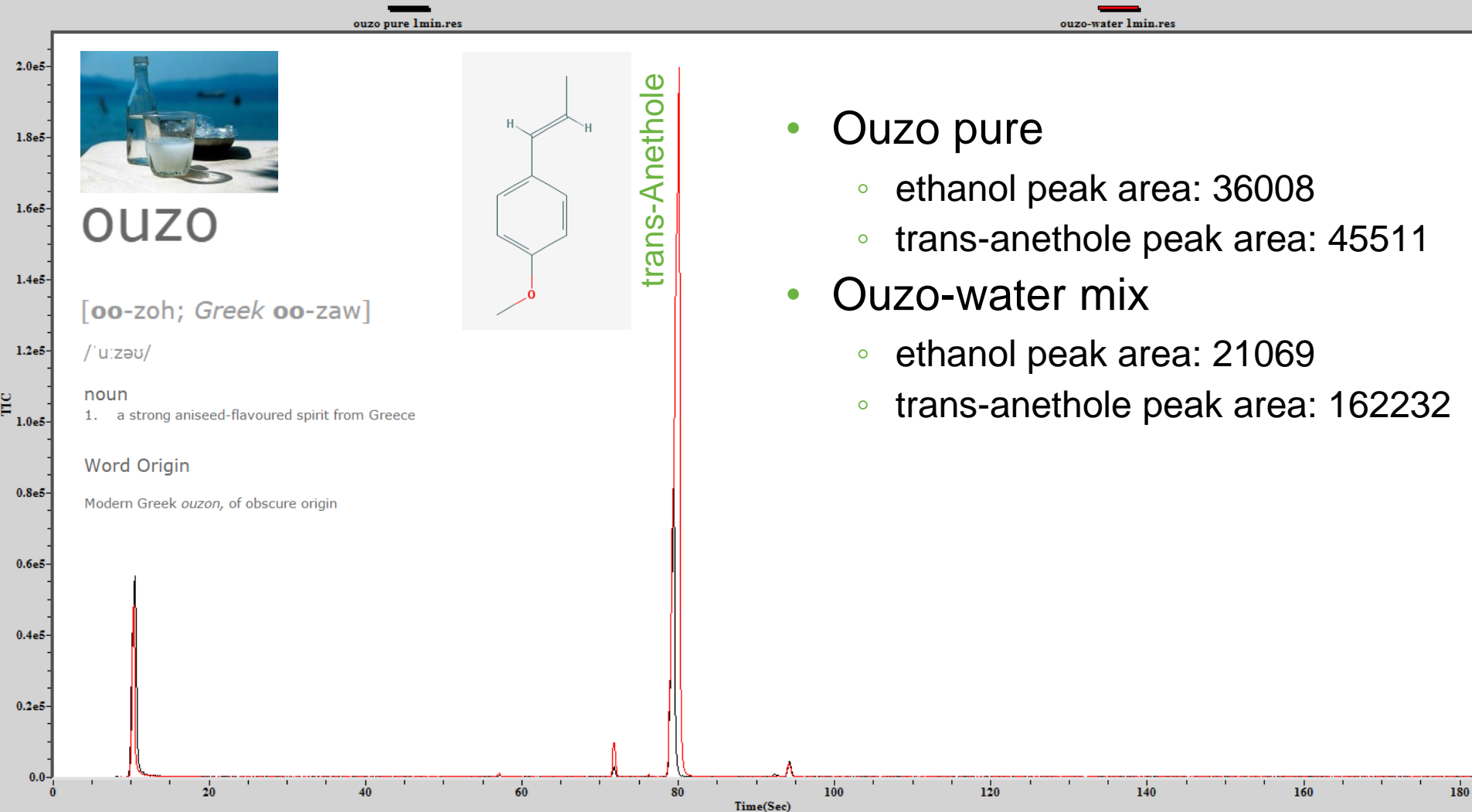
15. Dodecane



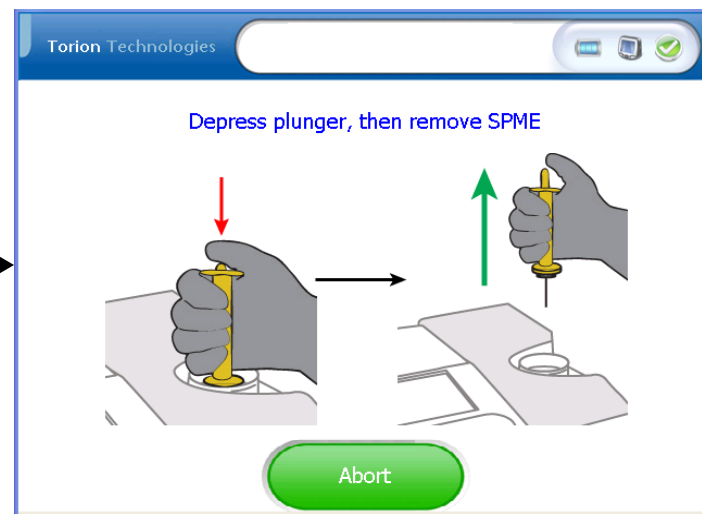
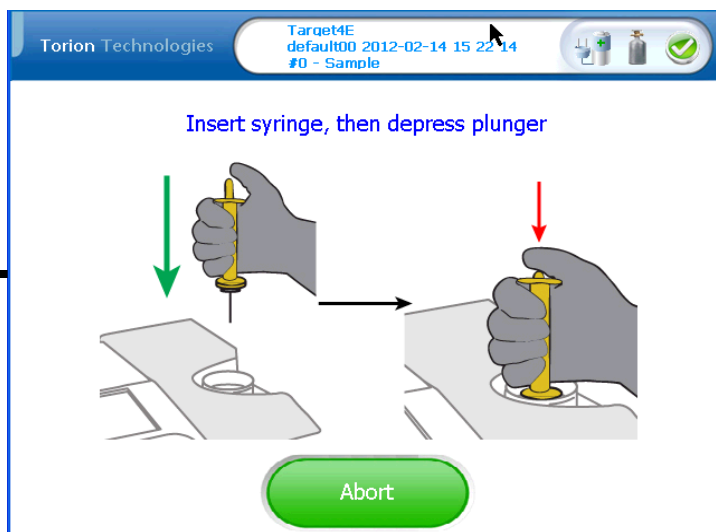
Analysis of Raspberry flavor



The Ouzo-effect



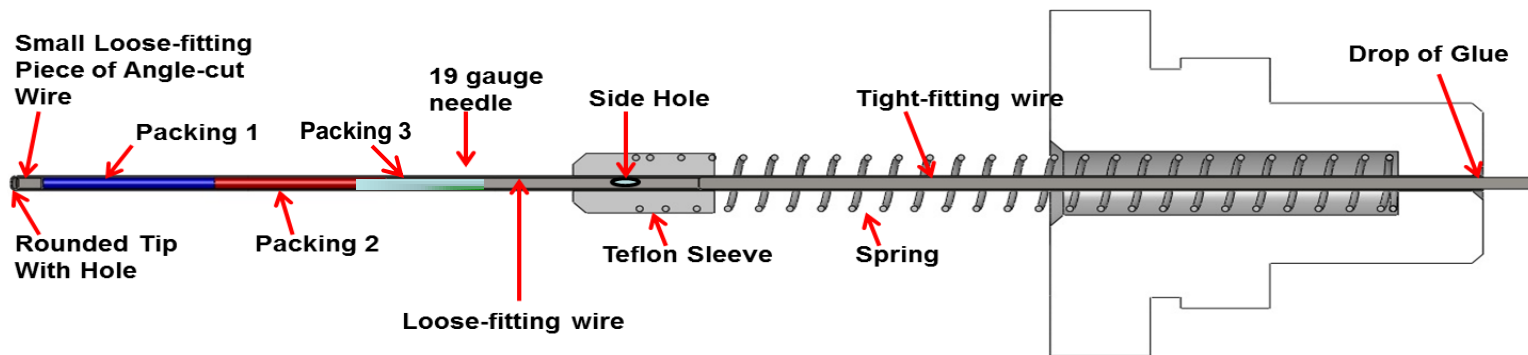
Method driven and automated injection sequence



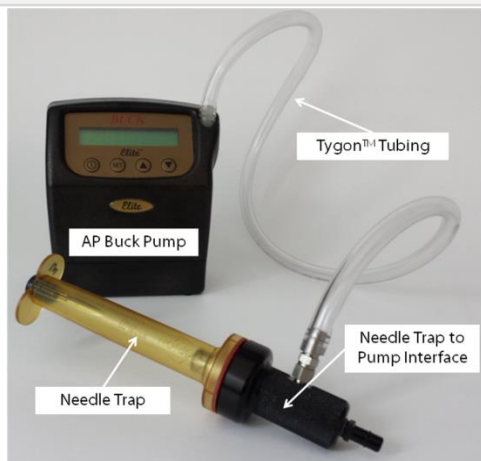
Thermal Desorption (air sampling)

CUSTODION®-NT (Needle Trap)

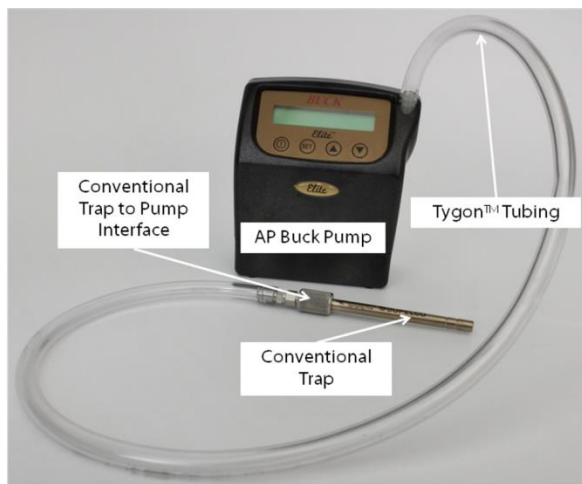
- Tri-Bed Packings:
 - #1: Tenax® TA
 - #2: Carboxen 1016
 - #3: Carboxen 1003
- Gas Phase Sampling
- Internal Standard Addition for Quantitation



CLAIRION™ Air Samplers



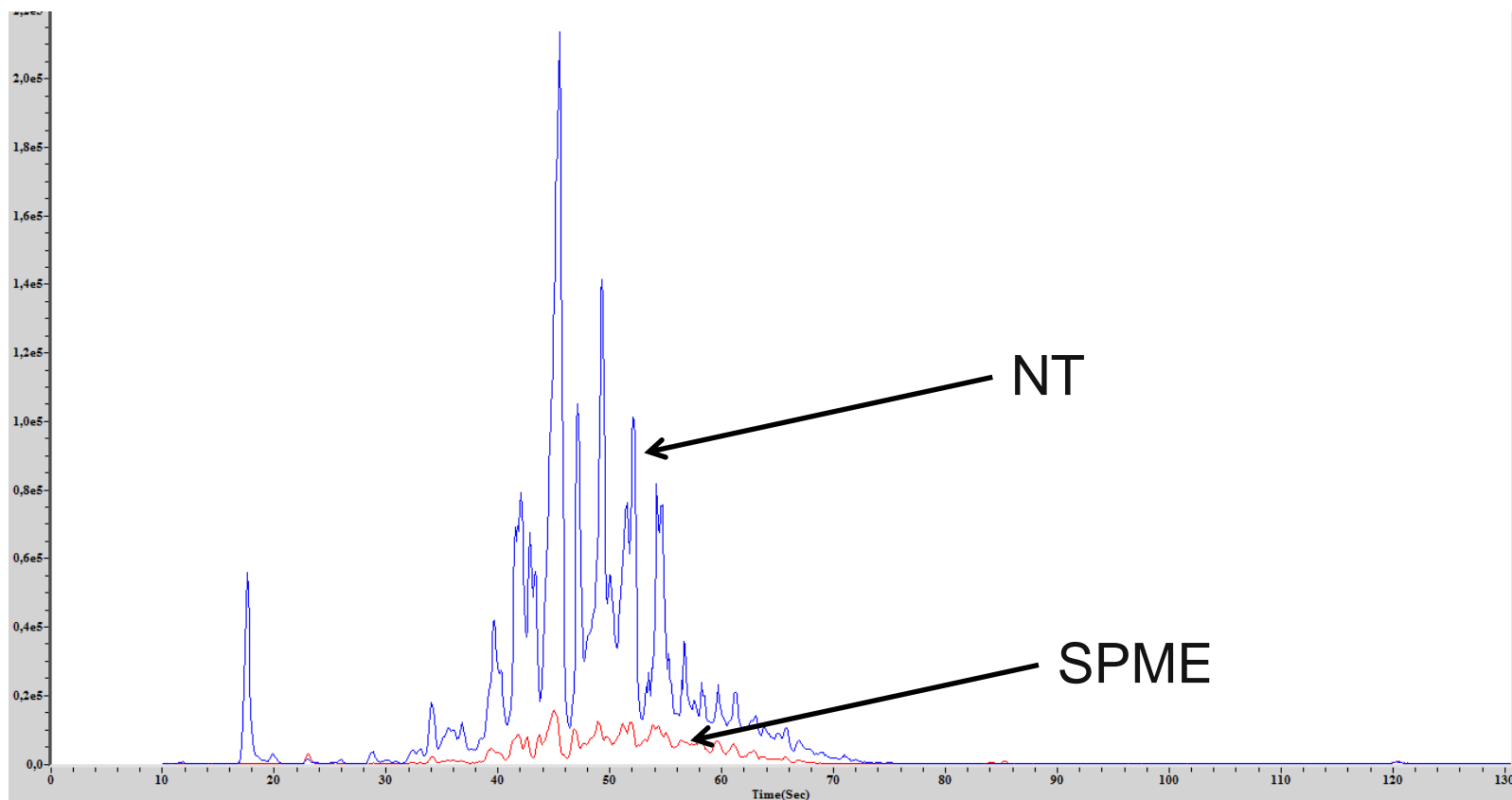
with CUSTODION™-NT



with CUSTODION™-CT

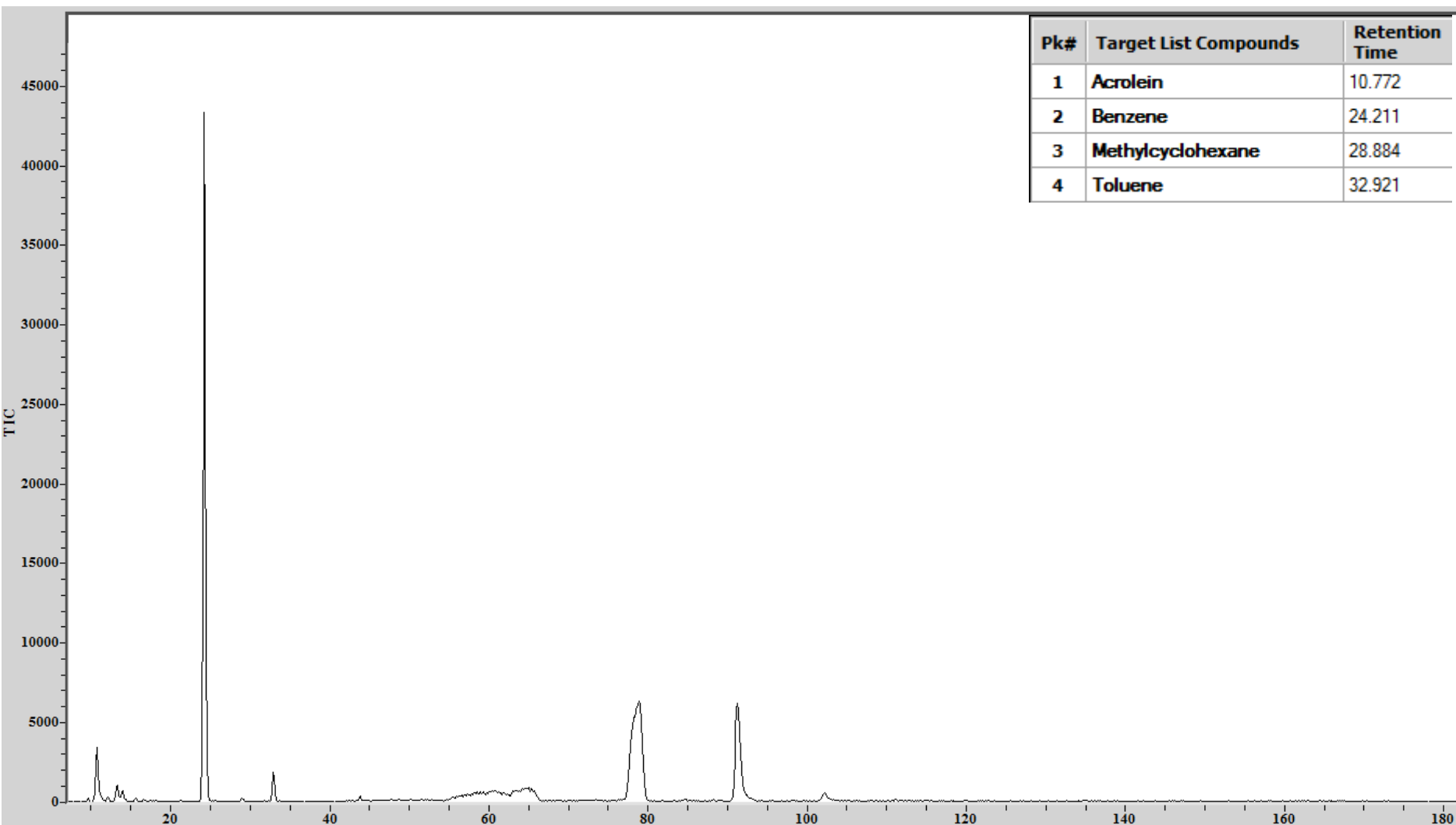
- Air Sampling Pump
 - Palm Portable Size: 107 x 58 x 173 mm (0.82 kg)
 - Rechargeable Battery – 27 hrs at 1 L/min (best case)
 - LCD with 2 lines of 16 characters
 - Flow rates: 5 mL/min to 5 L/min
- CUSTODION™-NT (Needle Trap)
 - Small and hand portable
 - Multiple sorbent beds (up to 3)
 - Interfaces with GC injection port
 - Achieves PPB detection (2 min)
- CUSTODION™-CT (Conventional Trap)
 - Industry standard (PKI) sorbent tubes (stainless steel)
 - Multiple sorbent beds (up to 4)
 - Interfaces with NT (sample transfer)
 - Achieves PPT detection (~5 min)
- Quantitative air sampling
- Design permits multiple samples to be collected simultaneously

Comparison between Needle Trap and SPME

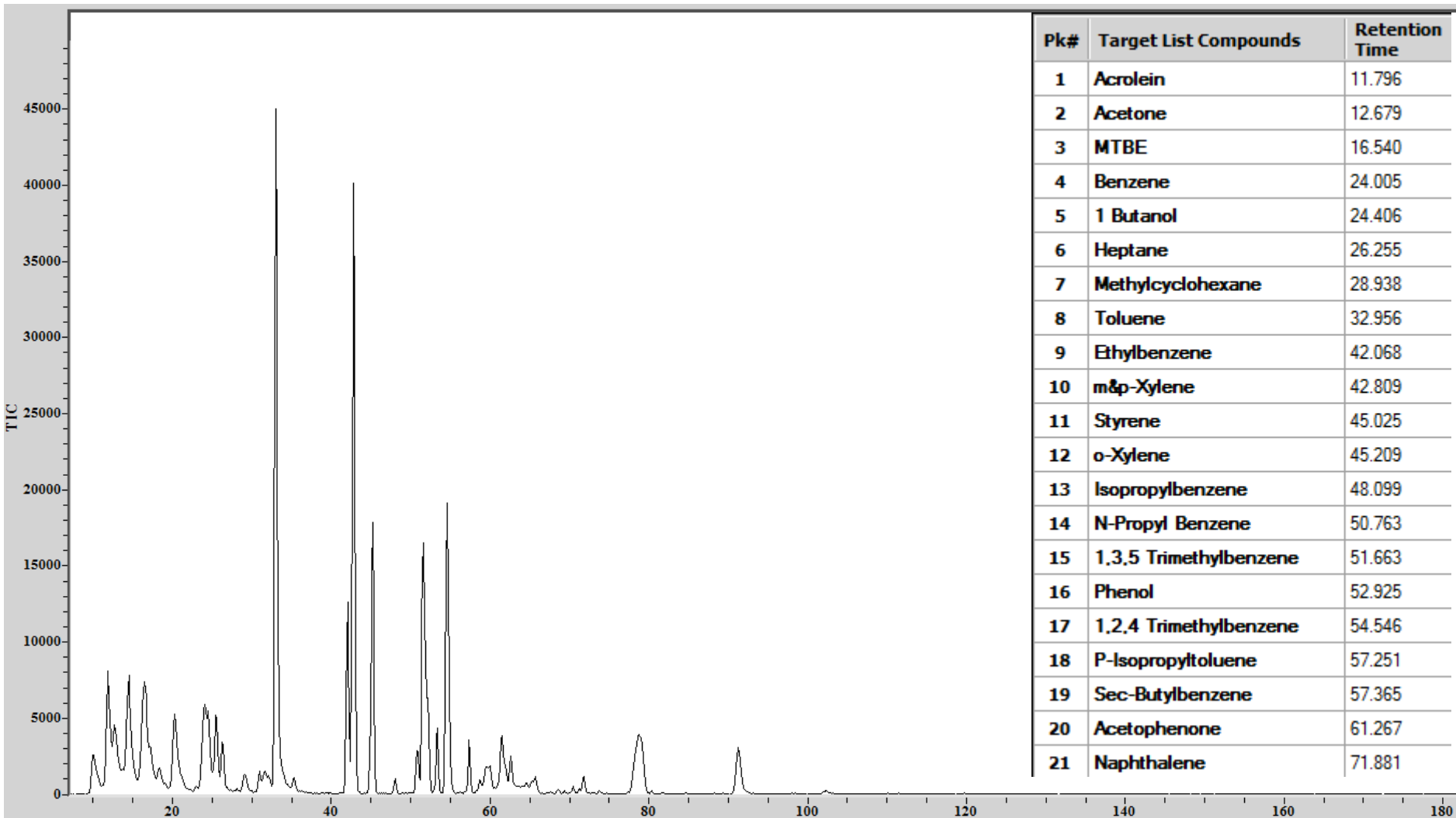


TIC of a **paint sample**: SPME PDMS/DVB 10 sec, Split 10:1 mode; 20 s, 270°C injection; 50°C hold 10 s initial, 2°C/s rate, 270°C hold 10 s final.

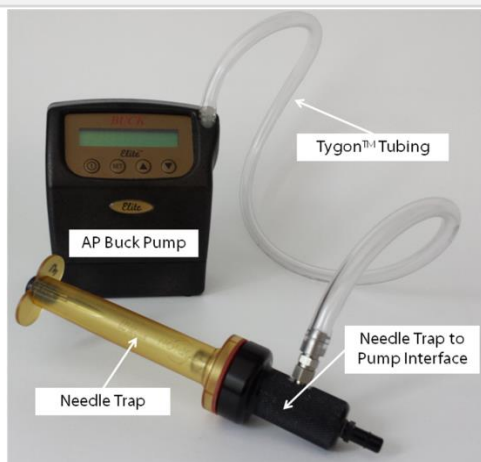
DIESEL car exhaust



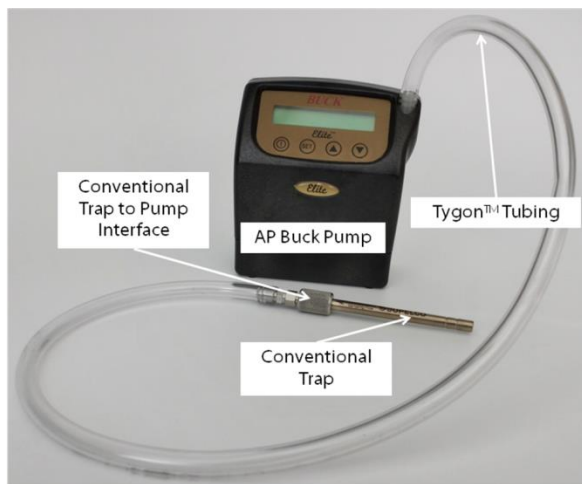
PETROL motor bike exhaust



CLAIRION™ Air Samplers



with CUSTODION™-NT



with CUSTODION™-CT

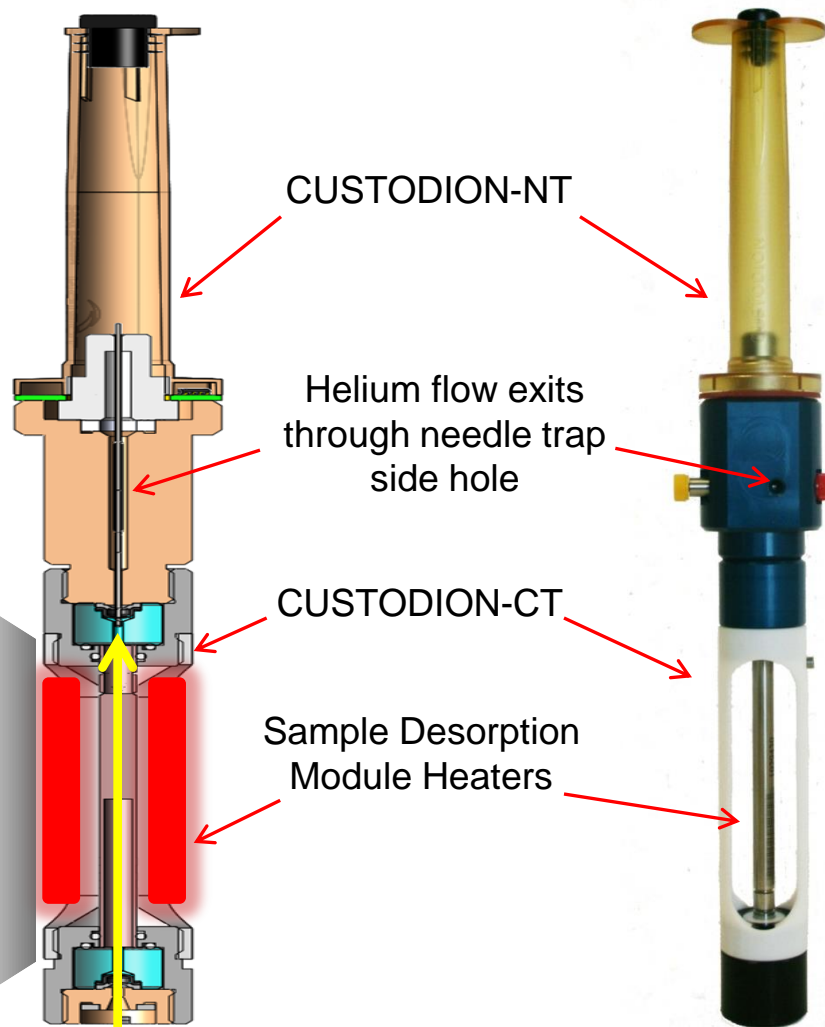
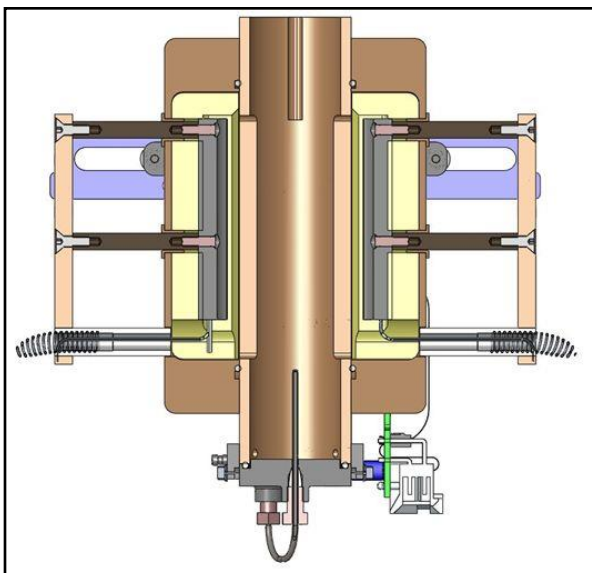
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- Quantitative air sampling
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SPS™-3 Sample Desorption: CT to NT Transfer Module

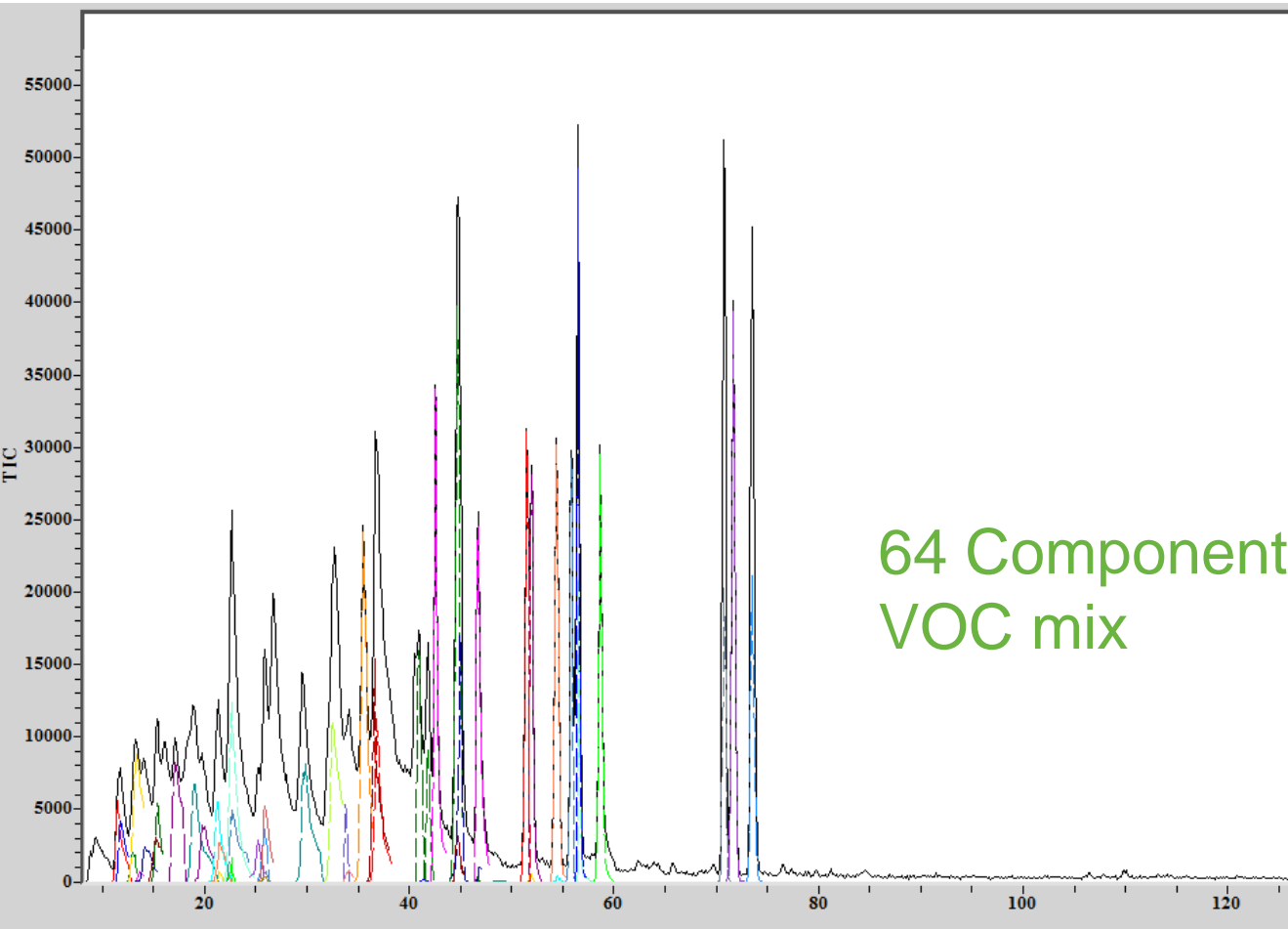


- Weight 4.8 kg (10.05 lbs)
- Size: 31.8 x 27.4 x 19.8 cm
- On-Board helium desorption gas for 80 runs
- Sample desorption from conventional trap to needle trap
- On battery 15-20 runs at 300°C and 5 minute desorption time
- Internal Standard (IS) addition

SPS™-3 Sample Desorption: CT to NT Transfer Module



Analysis of VOCs in air



Pk#	Target List Compounds	Retention Time	Response	Match Factor
1	Trichlorofluoromethane	11.444	3953	99.4
2	Acetone	11.708	3193	95.2
3	1,1 Dichloroethene	12.919	1061	96.1
4	Methylene Chloride	13.578	355	91.4
5	Carbon Disulfide	14.117	2580	99.8
6	Trans 1,2 Dichloroethene	15.191	2835	98.6
7	MTBE	15.305	3419	99.2
8	Chloroform	18.949	7627	99.9
9	Tetrahydrofuran	19.726	3957	98.6
10	1,1,1 Trichloroethane	21.293	4690	99.9
11	Acetic Acid	21.407	293	90.2
12	1,2 Dichloroethane	21.526	2409	94.3
13	1 Butanol	22.629	357	91.8
14	Carbon Tetrachloride	22.629	10160	95.9
15	Benzene	22.629	5241	98.6
16	Heptane	25.156	1924	95.9
17	Bromodichloromethane	25.795	178	93.6
18	1,2 Dichloropropane	25.795	2145	96.4
19	Trichloroethene	25.901	3760	96.8
20	Chloroacetone	26.006	271	84
21	p11	32.521	11745	99.8
22	p2	33.749	1662	99.8
23	Piperidine	34.135	445	89.7
24	Chlorodibromomethane	35.491	16961	99.6
25	Perchloroethylene	36.799	8676	99.1
26	Chlorobenzene	41.351	71	96.8
27	Ethylbenzene	41.842	3094	99.3
28	m&p-Xylene	42.527	15862	99.4
29	Styrene	44.765	1690	98.9
30	o-Xylene	46.636	61	88
31	Bromoform	46.910	296	92.3
32	Isopropylbenzene	48.918	45	98.8
33	1,3,5 Trimethylbenzene	51.943	10354	99.4
34	Bis 2 Chloroethyl Ether	51.943	171	89.4
35	1,2,4 Trimethylbenzene	54.398	12504	99.6
36	2 Chloro Ethyl Ether	54.486	119	89.3
37	1,3-Dichlorobenzene	55.823	10104	99.5
38	1,4-Dichlorobenzene	56.531	3763	98.7
39	1,2-Dichlorobenzene	58.637	10951	99
40	1,2,4 Trichlorobenzene	70.768	7557	86.4
41	Naphthalene	71.694	14099	100
42	Hexachlorobutadiene	73.480	8739	94.5

Different samples? Choose the right strategy...

Quickly collect sample and inject into T-9

Collect Sample
With SPME



Directly Inject
into T-9



For Dilute or Larger Volume Samples use NT

Collect Sample
w/ NT Basic kit



Add IS for
Semi Quant



Inject into T-9



For even more Dilute or Larger Volume Samples use CT

Collect Sample
w/ CT Basic kit



Assemble CT-NT
Interface



CT to NT Sample
transfer W/ SPS-3



Add IS for
Semi Quant



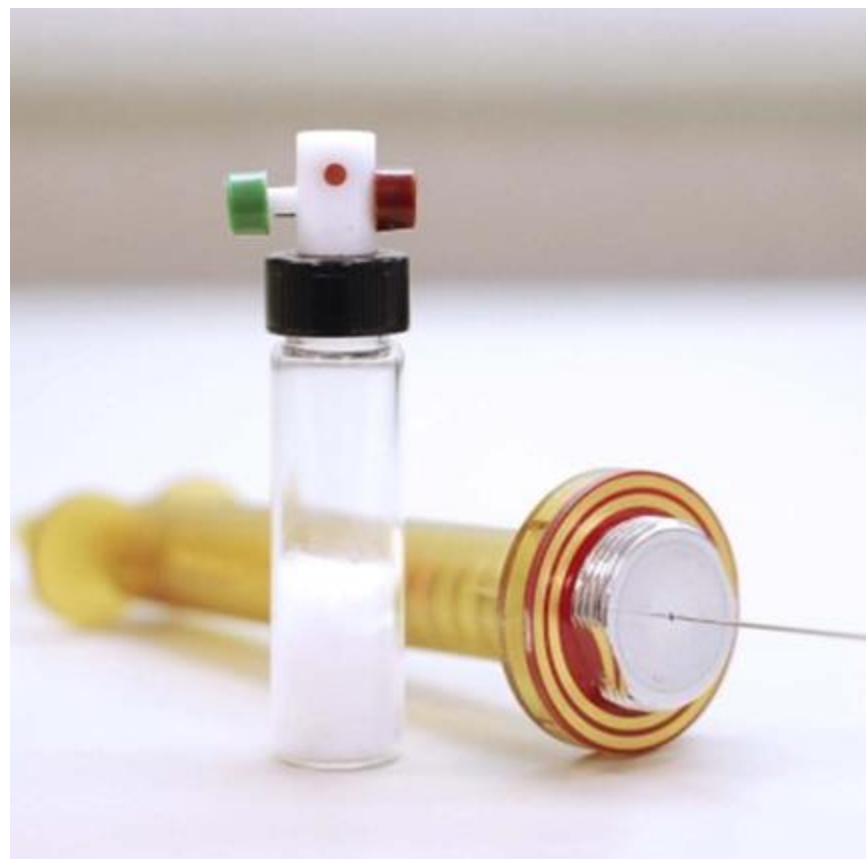
Inject into T-9



In-Field Calibration: CALION™ Standards

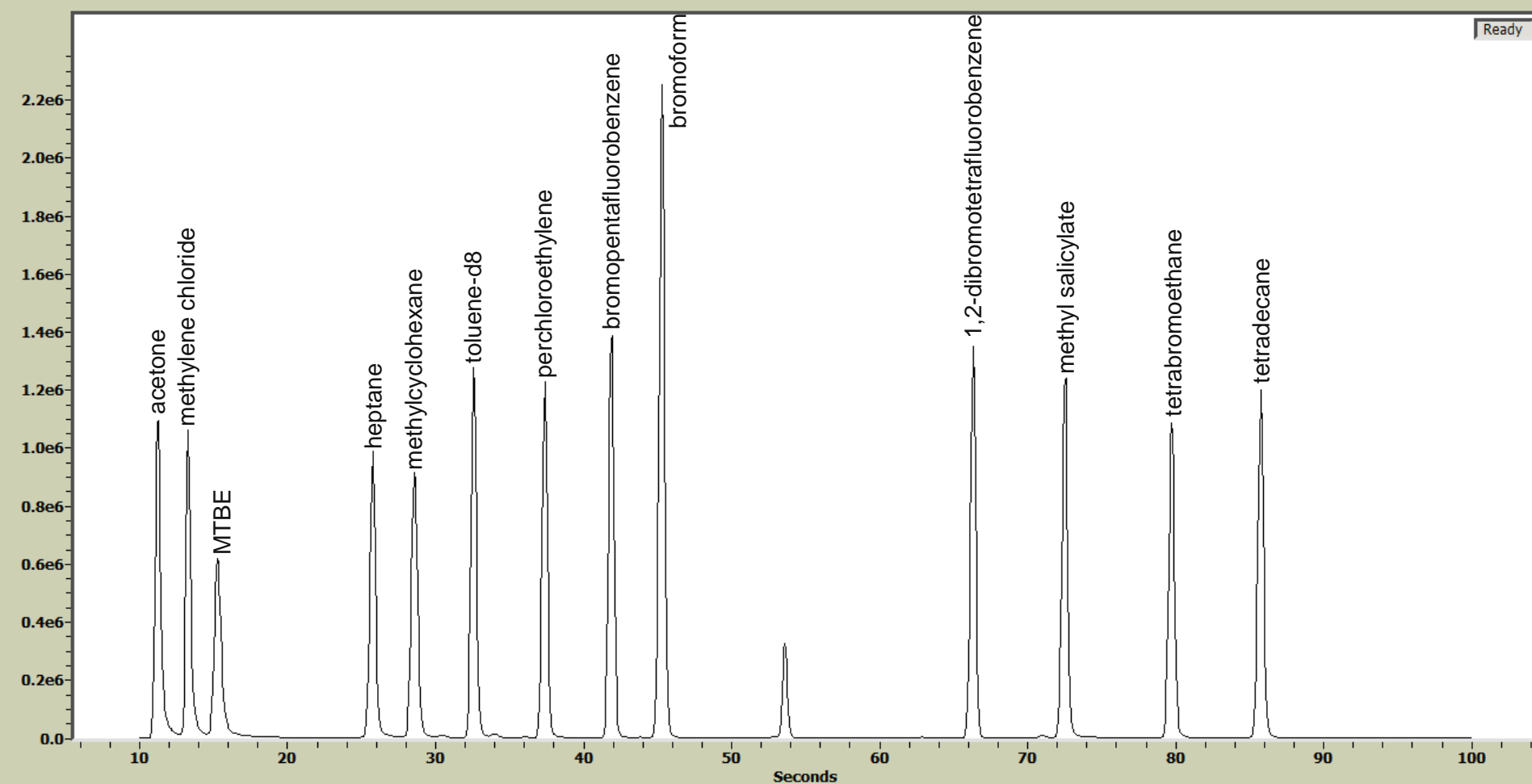
CALION™ Standards:

- Liquid Standards Desorbed onto a Solid Phase
- No Mixing
- No Spilling
- No leaks
- Typically lasts ~6+ months
- Used for AUTO-TUNE routine



CALION™ Standards: Auto Tune tests performed

Identification:	Compound ID					
GC:	Asymmetry	Retention time	Sensitivity			
MS:	Baseline	Mass calibration	Spectral quality	Resolution	Background	





Key Specifications

Key Specifications: break-down by “portability”

	PerkinElmer
	Torion T-9
Low weight	14.5 kg (including battery)
Small dimensions	38.1 cm x 39.4 cm x 22.9 cm (= 34.4 L)
On-board carrier gas	90 cc, ultra-high purity (99.995%) helium, typically 100 - 150 analyses per cylinder
On-board power supply	Rechargeable Li-Ion battery, up to 2.5 h lifetime, 15-20 runs per battery charge (~ 120 W peak power requirement, ~ 60 W average power)
On-board operations	5.7" color touch-screen display with on-board operating menus and navigation key-pad

- Only weighs 14.5 kg.
- Can run for ~ 3 days (8 h) on one helium cylinder.
- One full battery charge will last for 2.5 hours.

Key Specifications: break-down by “GC”

PerkinElmer	
Torion T-9	
Fast GC cycle time	typically 3 min elution, < 5 min cycle time (column: MXT-5, 5 m x 0.1 mmID x 0.4 µm)
GC oven temperature	40°C - 300°C
Easy sampling	Custodion SPME syringe (65 µm PDMS-DVB fiber) Custodion Needle Trap Sample Prep Station (SPS-3)

- Sharp peaks and fast chromatography.
- High upper temperature limit, both VOCs and SVOCs.
- Multiple tools for different sample types (solids, liquids, air) and sample concentrations.

Key Specifications: break-down by “MS”

	PerkinElmer
	Torion T-9
Fast pump-down	~ 5 min start-up time (dual stage vacuum system: nominal operating pressure 10^{-3} to 10^{-4} Torr)
Built-in performance validation	Calion PV mix, in-field calibration and pass/fail performance validation (in combination with Custodion SPME syringe)
Built-in library search	1100 compounds in T-9 library, NIST 2014 with Chromion software
Mass range	41 - 500 m/z

- Quick, easy, maintenance free vacuum system.
- In-field performance test ensures reliable results.
- Multiple library search options, including MS NIST.
- Wide mass range up to 500 m/z, both VOCs and SVOCs.



Summary

Complete Solution

Sample



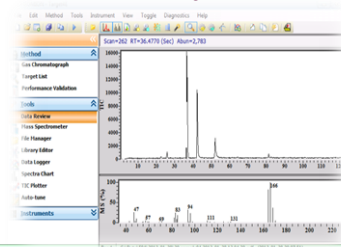
Concentrate
Add IS



Measure



Analyze



Keep it up



Complete workflow



AIR TESTING



WATER TESTING



SOIL TESTING



FIRST RESPONDERS



Thank you

Fast Results
Anytime,
Anywhere